THE EFFECTS OF HUMAN ACTIVITIES ON THE DISTRIBUTION AND ABUNDANCE OF THE LEPIDOPTERA.

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As with most aspects of the study of the ecology of the British Lepidoptera, comparatively little has been published on the effects of human activities on the distribution and abundance. The following brief summary of the available information may be of value in drawing attention to points on which further information is desirable; most of the examples quoted are the only records of their type.

In the British Isles human activities have been detrimental to a very large number of Lepidoptera and beneficial only to a minority. The species which have been most seriously affected are those characteristic of woodlands. In prehistoric times the British Isles were covered with dense forests from sea-level up to as high as 2000 feet on the hills, while at the present day less than 5% of the country is wooded and only a small proportion of this is the remnants of the native forests.

Some examples of local extinctions due to the destruction of woodlands are on record. For instance, James (*Ent. Rec.*, XXXV: 161) states that the cutting of Chattenden Woods, Kent, resulted in the extinction in that area of such species as *Melanargia galathea*, *Strymonidia w-album*, *Diacrisia sannio*, *Lygephila pastinum*, and *Siona lineata*. A larger number of extinctions, although not recorded as such, may be inferred from the old records for species from woodlands which no longer exist. There is little recorded information on the effects of the extensive clearance of woodlands which was carried out during the recent war.

There is no definite record of any species having become wholly extinct in the British Isles as a result of the cutting of the woodlands, but there is a possibility that this may have happened to *Notodonta tritophus*, *N. torva*, *Cryphia algae*, *Synvaleria oleagina* or *Meyenaphria bimaculosa*.

The thinning of the trees in a woodland is detrimental to the tree-feeding species and the haulage of the logs through the undergrowth must destroy many ova, larvae and pupae of species which feed on the smaller woodland plants. Generally speaking, however, the thinning of the trees is beneficial to the latter species as it permits more light to reach the undergrowth which may increase in consequence. For example, it is recorded (James, *Entom.*, LVII: 285) that the thinning of a wood in Essex resulted in the disappearance of the tree-feeding *Comibaena pustulata* and *Boarmia roboraria* but the resultant increase of scrub Birch was followed by an increase of *Parastichtis suspecta*. Local increases of such species as *Cucullia asteris*, *Eulype hastata* and *Ecliptopera silaceata* have been attributed to their foodplants becoming abundant in the newly-cleared parts of woods and it is well known that *Melitaea athalia* prefers one-year-old clearings.

The clearing of the undergrowth in woods is detrimental to species which, like *Apatura iris* and *Limenitis camilla*, are associated with the shrub layer but is beneficial to the herb-feeders. Scarcities of the latter may result if the undergrowth is allowed to grow unchecked (Eastwood, *Entom.*, LVIII: 104; Conquest, *Ibid.*, XXX: 102; Castle Russell, *Trans. S. Lond. ent. nat. Hist. Soc.*, 1941-2: 40).

All or most of the Lepidoptera characteristic of swamps, marshes, fens, bogs and damp grasslands have undergone numerous local extinctions as a result of reclamations of their habitats. In most cases these situations have been drained as a preliminary to cultivation but in the case of the bogs which cover large areas of Ireland the purpose has been to permit the cutting of the peat for fuel. I am indebted to Mr T. Greer for a description of the changes which took place over a period of 40 years in the large area of bogland south and east of Lough Neagh as a result of this. In parts of this bogland there were extensive areas of Birch and Oak which were felled ruthlessly with the result that such species as *Pheosia gnoma, Tethea duplaris, Achyla flavicornis, Drepana falcataria, Diarsia dahlii* and *Parastichtis suspecta* became rare. Local extinctions of *Apatele menyanthidis, Amathes agathina, A. glareosa, Dasychira fascelina, Scopula inornata, Dyscia fagaria, Selidosema plumaria, Perconia strigillaria, Callophrys rubi* and other species followed when the remaining vegetation was burnt off. *Coenonympha tullia* is the first species to disappear when a bog is drained and is now almost extinct in the area, although formerly common. When the bogs had been exhausted of the peat suitable for fuel the drains and pools became colonised by various freshwater plants with the result that such Lepidoptera as *Apamea unanimis, A. ophiogramma, Celaena leucostigma, Hydraecia crinanensis, Nonagria typhae* and *Eustrotia uncula* became abundant.

The initial operations necessary for the reclamation of a marsh or fen are similar: the vegetation is burnt off and the area is drained, with the result that the marsh plants, and their associated Lepidoptera, disappear. The most marked recorded effects of this took place when the East Anglian Fenlands were drained about the middle of the 19th century. This was primarily responsible for the extinction as British species of *Lycaena dispar, Lymantria dispar, Caenophila subrosea, Laelia coenosa* and *Euphyia polygrammata* and for a large number of local extinctions of other species in the area. Similar local extinctions resulted from the reclamation of the Thames marshes in the London area, judging from the older records.

The areas reclaimed from heath and moorland have been small in comparison with the areas that remain. There is no definite evidence that any species has become wholly extinct as an inhabitant of the British Isles as a result of such reclamations. Local extinctions, although numerous, have been less important than with the woodland and fen species. Again, the initial clearance operation is the burning-off of the vegetation and it is recorded that local extinctions of *Epicnaptera ilicifolia* and *Coscinia cribraria* and local scarcities of *Nonagria neurica, Sterrha eburnata* and *Isturgia limbaria* have resulted from this (Freer, *Ent. Rec.*, VI: 238; Capper, *Ibid.*, XV: 122; Mera, *Ibid.*, XIX: 122; James, *Ibid.*, XXXIV: 170; Wightman, *Ibid.*, XLI: 85).

Fire appears to cause great destruction and its effects on different species require investigation, as there is some indication that different species may be affected to different degrees. Thus, Perkins (*Entom.*, XVI: 249) states that many species became scarce locally as a result of fire on dry hillsides but *Macrothylacia rubi, Procris statices* and the Crambidae were unaffected. Probably the importance of fire depends on whether a species feed high up or low down on the vegetation. Many

of the local extinctions of *Maculinea arion* have been attributed, at least partially, to fire (Bignell, *Entom.*, XX: 234; Conquest, *Ibid.*, XXX: 102; Oliver, *Ibid.*, LIII: 279; Milman, *Ibid.*, LVIII: 144; Goss, *Ent. mon. Mag.*, XXVII: 58). An interesting effect is described by Blair (*Proc. S. Lond. ent. nat. Hist. Soc.*, 1928: 62) who states that the firing of the Scottish grouse moors in strips influences the occurrence of *Anarta cordigera*, as its foodplant, Bearberry, is slow to recover.

The replacement of the natural vegetation by grassland or cultivated land over the greater part of the British Isles must have resulted in great increases in the Lepidoptera characteristic of these types of habitat. Such species originally must have inhabited the margins and glades of the native forests. According as each region was cleared of its trees it was colonised by these species, which have replaced the woodland Lepidoptera as the dominant species in most areas. However not all the grassland species have expanded their distributions. Some, such as *Maculinea arion*, *Pachetra sagittigera* and *Scopula marginepunctata*, probably have not spread from the regions they inhabited at the time the native forests existed.

The cleared and reclaimed areas were divided and sub-divided into fields which in most cases are separated from each other by hedges. Consequently those Lepidoptera which feed on hedgerow shrubs and herbs must now be far more abundant and more widely distributed than they were when they inhabited the margins of the native forests. Large quantities of Hawthorn and other plants have been imported from abroad for hedging purposes but there is no evidence that any species of Lepidoptera has been added to the British fauna in this way.

The effects of normal farming operations on the Lepidoptera would make an interesting study but at present apart from scattered notes little information on this is available. Some examples of the recorded effects may be noted. The ploughing-up of previously uncultivated areas has resulted in local extinctions of such species as *Coscinia cribraria*, *Epirrhoe galiata*, *Melanargia galathea*, *Coenonympha tullia*, *Melitaea athalia*, *Maculinea arion*, *Strymonidia w-album*, *Pieris napi*, *Hesperia comma* and *Erynnis tages* (Clarke, *Entom.*, XXII: 47; Arkle, *Ibid.*, L: 92; Harrison, *Ibid.*, VII: 51; Walsh, *Ent. mon. Mag.*, LI: 225). Local scarcities of *Cupido minimus* and *Cyaniris semiargus* have been attributed to hay-making (Jones, *Entom.*, LI: 100; Dale, *Ent. mon. Mag.*, XXXVIII: 76). Barrett mentions a local extinction of *Phothedes captiuncula* which took place when a field in which it occurred was mowed earlier than usual. Hutchinson (*Entom.*, XIV: 250) suggested that the collecting and burning of the Hop plants after the crop had been gathered may have contributed to a scarcity of *Polygonia c-album*. Wild Barberry is destroyed by farmers in wheat-growing districts as it acts as an alternative host for the Wheat-Blight Fungus and this, according to Barrett, has resulted in the extinction of *Coenotephria berberata* in many localities. A local decrease in the abundance of some butterflies was attributed by Marshall (*Entom.*, XXXIV: 58) partly to the destruction of ova, larvae and pupae when the hedges and herbage on the field margins were cut and the cuttings destroyed. *Caradrina clavipalpis*, unlike other grassland species, often is benefited by haymaking as the plants on which the eggs are laid may be incorporated

in haystacks or brought into barns where the larvae often are found in great numbers.

The increase of buildings and communications doubtless has caused many local extinctions but again comparatively few have been recorded. Apart from the actual destruction caused by the building operations the Lepidoptera are affected by the pollution of the atmosphere and foliage with smoke, fumes and sooty deposits. Results of this are on record (see, e.g., Rendall, *Entom.*, XX: 198; Meldola, *Ibid.*, XX: 235; Biggs, *Ibid.*, XX: 234; Fenn, *Ent. Rec.*, VI: 228; Walsh, *Ent. mon. Mag.*, LI: 225). Bond (*Entom.*, LVII: 207) and Oldaker (*Ibid.*, LXII: 20) suggest that many Lepidoptera may be killed by the fumes and specks of the tar used in road-making.

An incidental effect of the increase of communications is that it has resulted in the opening-up of formerly remote regions to cultivation and building and in the great increase of visitors to formerly unfrequented localities, with a consequent trampling of the vegetation and larvae. A further incidental effect has been the great increase in street-lighting. It is difficult to assess the effects of this on the Lepidoptera. Boursin (quoted by Wiltshire, *Ent. Rec.*, L: 84) suggests that the lights result in the surrounding country gradually becoming relatively depopulated of its lepidopterous fauna. The cumulative effect of the moths being attracted away from their foodplants year after year before they have had time to breed and lay their eggs must be of some importance but it would be difficult to obtain definite information.

Certain species tend to be especially common in urban districts. These must be species which are unaffected by pollution of the atmosphere and foliage but their abundance in some cases is due primarily to the abundance of their foodplants in gardens, in others probably to the relative scarcity of their natural enemies, chiefly birds, in towns.

The sea-coast species, which normally are unaffected by other types of human activities, have undergone some local extinctions as a result of the growth of seaside resorts. Thus, *Celama aerugula* and *Sterrha ochrata* formerly occurred commonly at Deal, Kent, but became very scarce there when a golf course and holiday camp were constructed on the sandhills (Tutt, *Ent. Rec.*, I. 129; Bull, *Ibid.*, IX: 273; James, *Ibid.*, XXXV: 161; Adkin, *Trans. S. Lond. Ent. Nat. Hist. Soc.*, 1927-8: 45). Local scarcities of such species as *Hadena caesia*, *Antitype xanthomista* and *Eustroma reticulata* have been attributed to the destruction of their foodplants by road-making (Clarke, *Ent. Rec.*, IV: 205; Booth, *Ibid.*, VI: 158; Nurse, *Entom.*, LI: 33). The construction of the golf course on the sandhills at Ballycastle, Co. Antrim, apparently has wiped out the colony of *Nyssia zonaria* which occurred there.

Large quantities of trees and shrubs have been imported into the British Isles from abroad and several species of Lepidoptera probably have been added to the British fauna in this way. Likely examples are *Eucymatoge pini* (*togata*) and *E. lariciata* and the Microlepidoptera *Leucoptera laburnella*, *Argyresthia laevigatella* and *Gracilaria azaleella*. The most important of these accidental importations have been of the conifer-feeding species. Many of these, in addition to the two just mentioned, may not have been indigenous species. All must have been artificially spread over the greater part of their ranges in the British Isles. All must have been artificially introduced into Ireland, as there is no

evidence that Pine, Spruce or Larch survive in that country as native trees. Some of the following may be wholly artificial introductions and all certainly have been artificially introduced into many parts of the British Isles: the conifer-feeding *Hyloicus pinastri, Panolis griseovariegata, Thera obeliscata, T. firmata, Semiothisa liturata, Eupithecia indigata, Ellopia prosapiaria, Cleora ribeata, Bupalus piniaria* and conifer-feeding Microlepidoptera, and also the following, which feed on Currant and Gooseberry: *Lygris mellinata, L. prunaria, Eupithecia assimilata, Itame wauaria* and *Aegeria tipuliformis. Cosymbia trilinearia, Hemistola chrysoprasaria, Eupithecia isogrammaria, Peronea sparsana* (*sponsana*) and *Lithocolletis faginella* must have been artificially introduced into Ireland as their foodplants are not natives of that country.

The destruction of the native forests has affected the Lepidoptera during the past 2000 years, the reclamation of the marshes, fens, heaths and moorlands mainly during the past 1000, and the increase of towns and communications chiefly during the past 200. Factors which have operated only within the past century are the increase of public lighting, mentioned above, and the effects of the intensive study of natural history.

One of the most important effects of the interest taken in natural history is that there has been a great increase in the abundance of insectivorous birds within the past 100 years, due partly to the increased use and availability of firearms, which has resulted in the increased destruction of hawks and other birds of prey, but primarily to the birds being protected from destruction by law. As birds are amongst the most important of the natural enemies of the Lepidoptera their increase must have had important results. Judging from the records in the entomological periodicals there seems to have been a gradual decrease in the abundance of the Lepidoptera as a whole during the past century and several writers (e.g., Frohawk, *Entom.*, XVII: 37; Meldola, *Ibid.*, XX: 225; Castle Russell, *Ibid.*, LVIII: 100, and *Trans. S. Lond. Ent. Nat. Hist. Soc.*, 1941-2: 40) have attributed this to the increase in bird-life. This seems to be a reasonable conclusion.

The protection of game birds, however, has been more beneficial than detrimental to most Lepidoptera, as it has resulted in the preservation of woodlands which otherwise might have been cut and their lepidopterous faunas destroyed. It has been detrimental in that the larvae and pupae of some of the species which feed on the smaller woodland plants may be destroyed in large numbers by game birds. Thus, it has been suggested that the exceptional abundance of *Argynnis euphrosyne, A. selene, Euphydryas aurinia* and other fritillaries in 1917-9 was due to a temporary decrease in the numbers of Pheasants and other game birds during the 1914-8 war (Castle Russell, *loc. cit.*). It is more probable that weather conditions were responsible for these increases.

The interest taken in the Lepidoptera has resulted in some species being deliberately established in localities in which they did not occur as natives and in some species being exterminated by over-collecting. I am in agreement with Dr E. B. Ford (*Butterflies*, p. 142) that the danger of over-collecting often has been unduly stressed. Over-collecting probably is rarely the primary cause of local extinctions but produces its effects in conjunction with other detrimental factors. Ex-

cept in a few well-known cases, e.g., *Lycaena dispar*, *Maculinea arion* and *Zygaena meliloti*, its importance in producing local extinctions is negligible in comparison with the importance of other factors.

To summarise the probable effects human activities have had on the British Macrolepidoptera. The destruction of the native woodlands has resulted in the total extinction as inhabitants of the British Isles of an unknown number of species. About 64% of the total number of surviving species have been affected by the destruction of the woodlands, this figure being made up as follows: about 31% have undergone numerous local extinctions and few or no expansions of their distributions, about 26% have undergone numerous local extinctions and probably some local expansions of their distributions, and about 7% probably are more abundant than in prehistoric times. About 2% of the total have been artificially spread over the greater part of their present ranges in the British Isles as a result of the planting of trees and shrubs, perhaps half of them being wholly artificial introductions. About 22% of the total, comprising chiefly species characteristic of grasslands or cultivated land, probably are more abundant and widely distributed than they were in prehistoric times. Most of them now occur in areas covering perhaps twenty times the areas of their former distributions while most of the woodland species have had their distributions correspondingly reduced. Incidentally there is no definite evidence that more than a negligible number have expanded their ranges in the British Isles, i.e., the total area of country within which they occur, as a result of the increase of their habitats. About 12% of the total number of species probably have not had their distributions or abundance changed to any important extent. Of these nearly half (5%)—mostly inhabitants of the mountains or the sea-coasts —probably have hardly been affected at all. The great majority of the total have been affected detrimentally to some extent by the increase of bird-life and other controlling factors which have become important within the past 100 years.

COLLECTING AT HOME: RECORDS OF A RAINY SEASON AT CLEVEDON.

By J. F. Bird, F.R.E.S.

Due, principally, to the Clerk of the Weather, our opportunities for collecting far afield were few; therefore our entomological activities, during 1946, were mainly conducted within the limits of our garden walls. Nevertheless, within that restricted area, and chiefly by the attraction of light, we were not altogether unsuccessful.

During a brief period of fine weather at the end of March and the beginning of April, we noticed, for the first time in this locality, a fair number of *Brephos parthenias*; a few, even, flying erratically past our windows. One surprised us, on 1st April, by alighting on a concrete path by the side of the house where it, a female, was eventually netted by my youngest son; a most unexpected capture in one's garden. Another unusual find in the garden was a larva of *Lasiocampa quercus*, discovered by my wife on a gooseberry-bush, from which I reared a male